

National Aeronautics and Space Administration



# Dynamic Weather Routes

## *A Weather Avoidance Concept for Trajectory-Based Operations*

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Airspace Systems Program  
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[www.nasa.gov](http://www.nasa.gov)





# Background

- No real-time automation to find better weather routes
- Integrated operation of wind-route analysis, trial planning, and weather modeling triggers analysis
- Closed trajectories desirable for trajectory-based ops
- Today's data comm appears suitable for weather routes

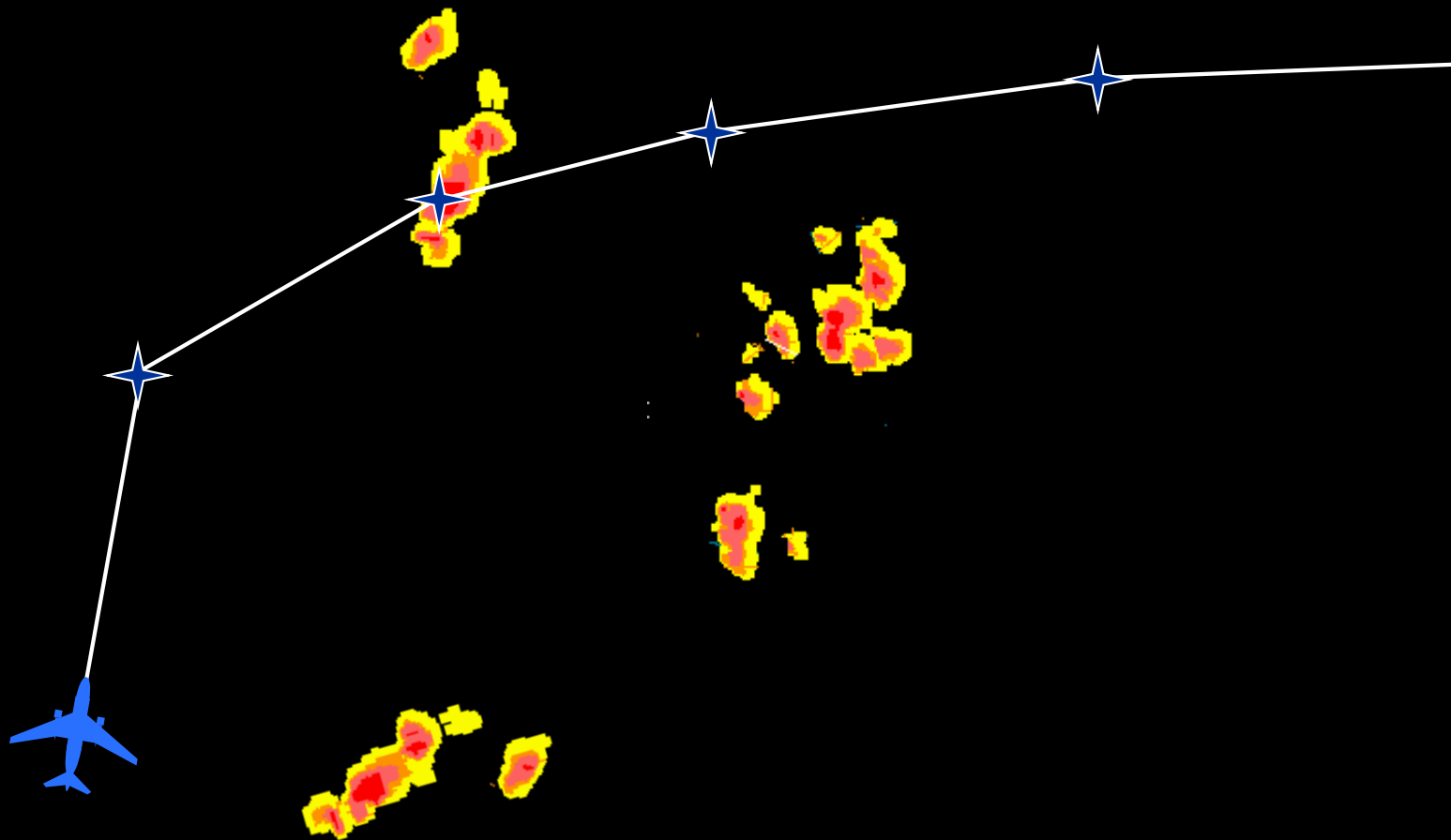


# Objective

Trajectory automation and metrics for real-time identification and evaluation of time and fuel saving convective weather reroutes

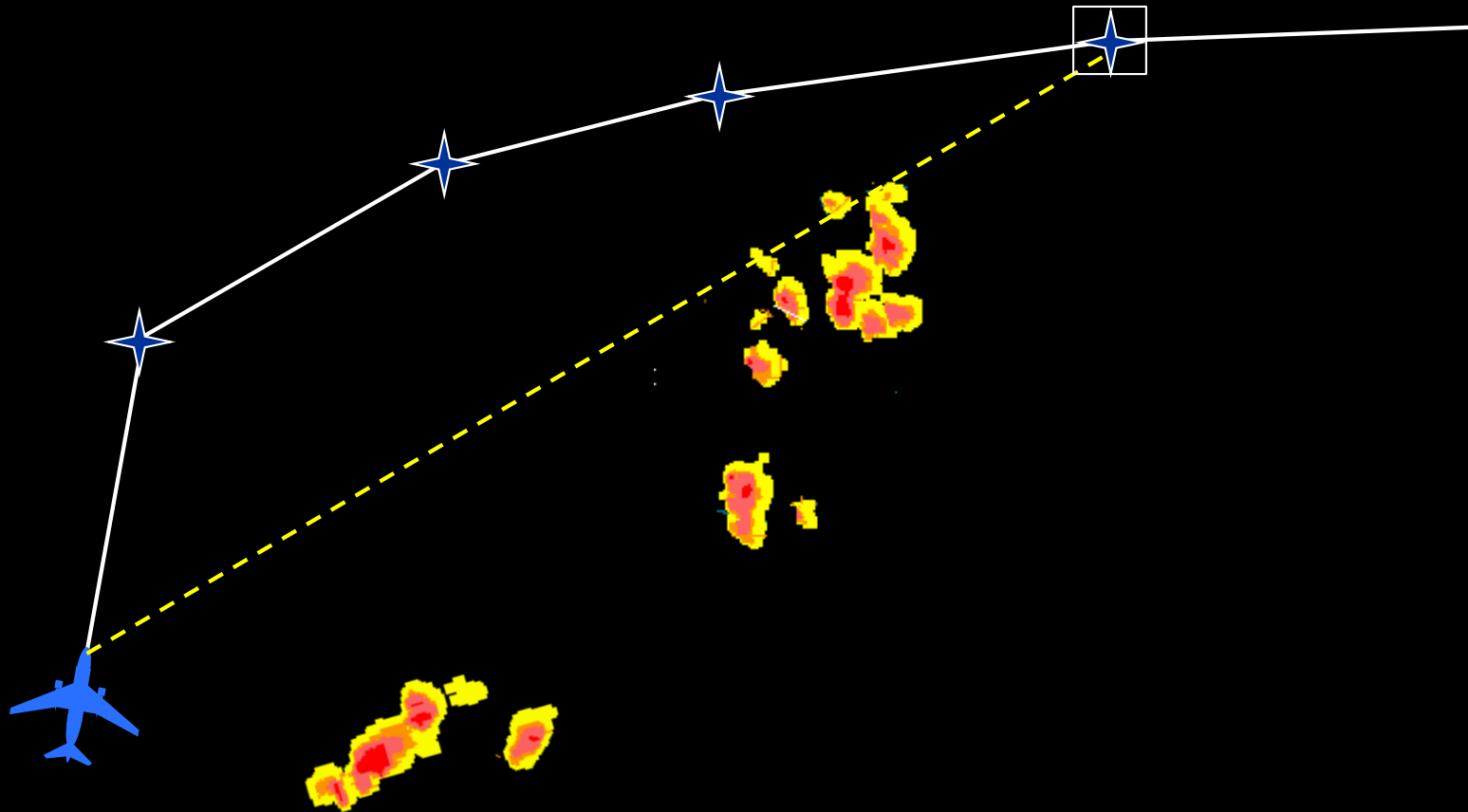


# Nominal Weather Route



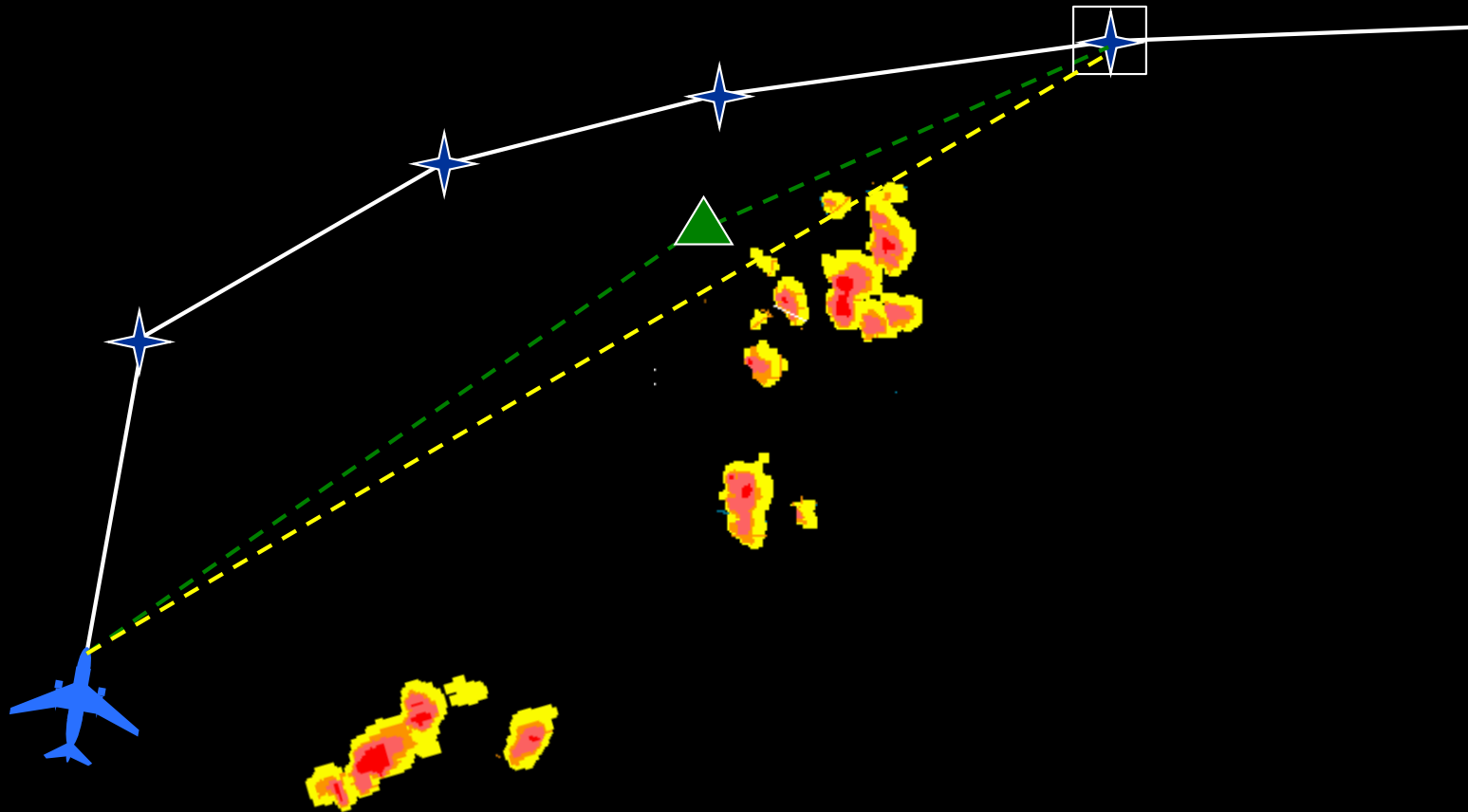


# Direct-To Triggers Analysis



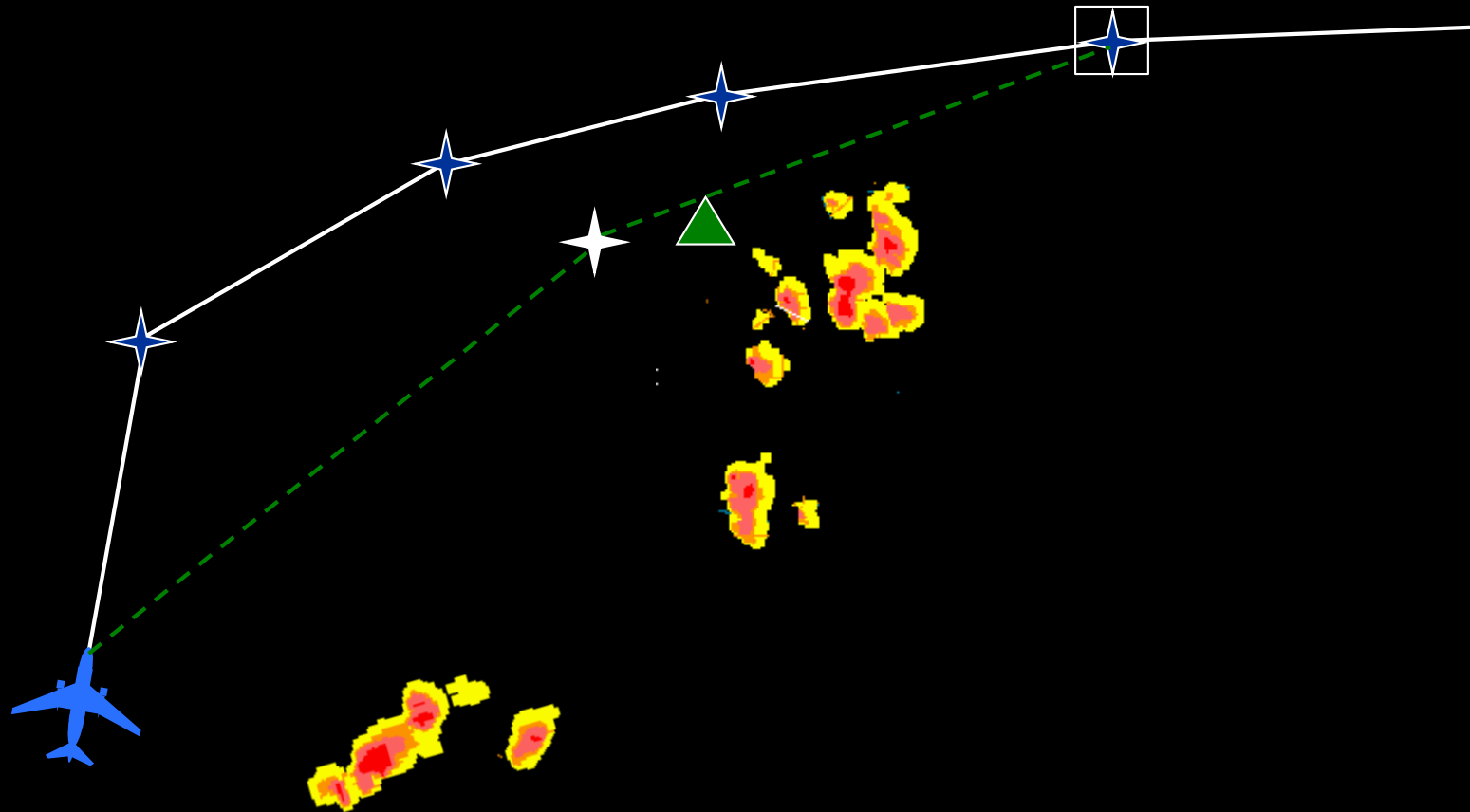


# Resolve Weather Conflicts



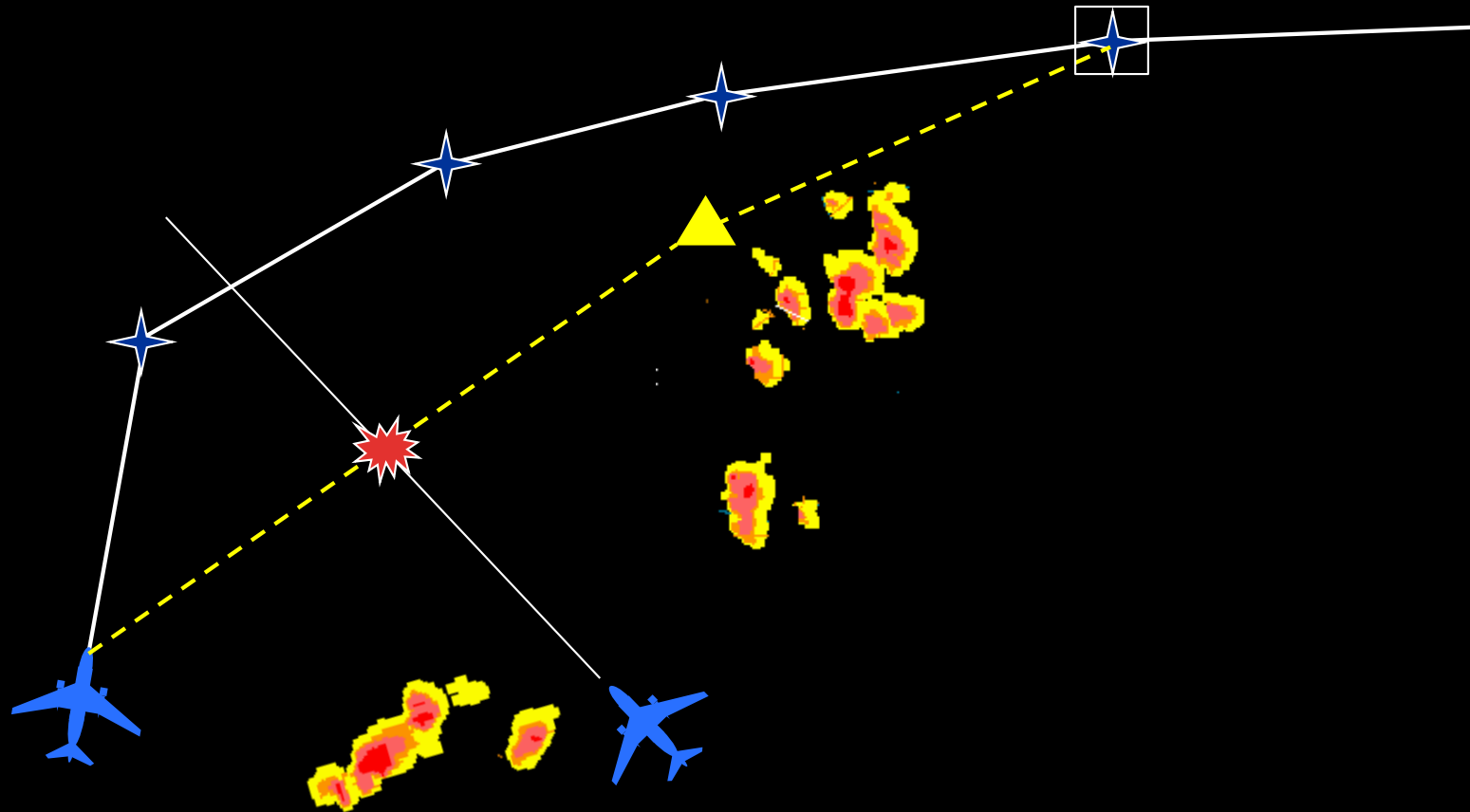


# Snap to Named Fixes





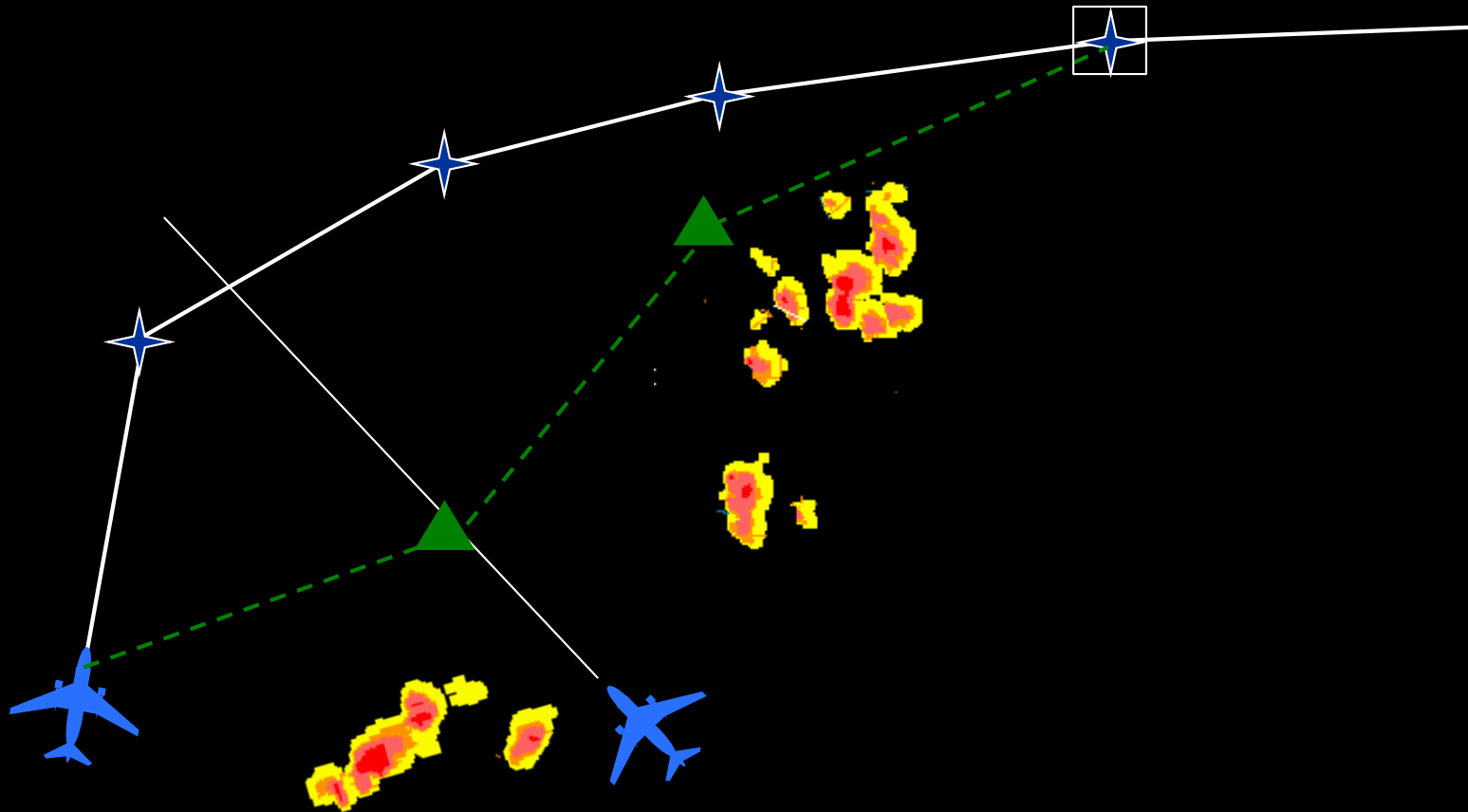
# Detect Traffic Conflicts





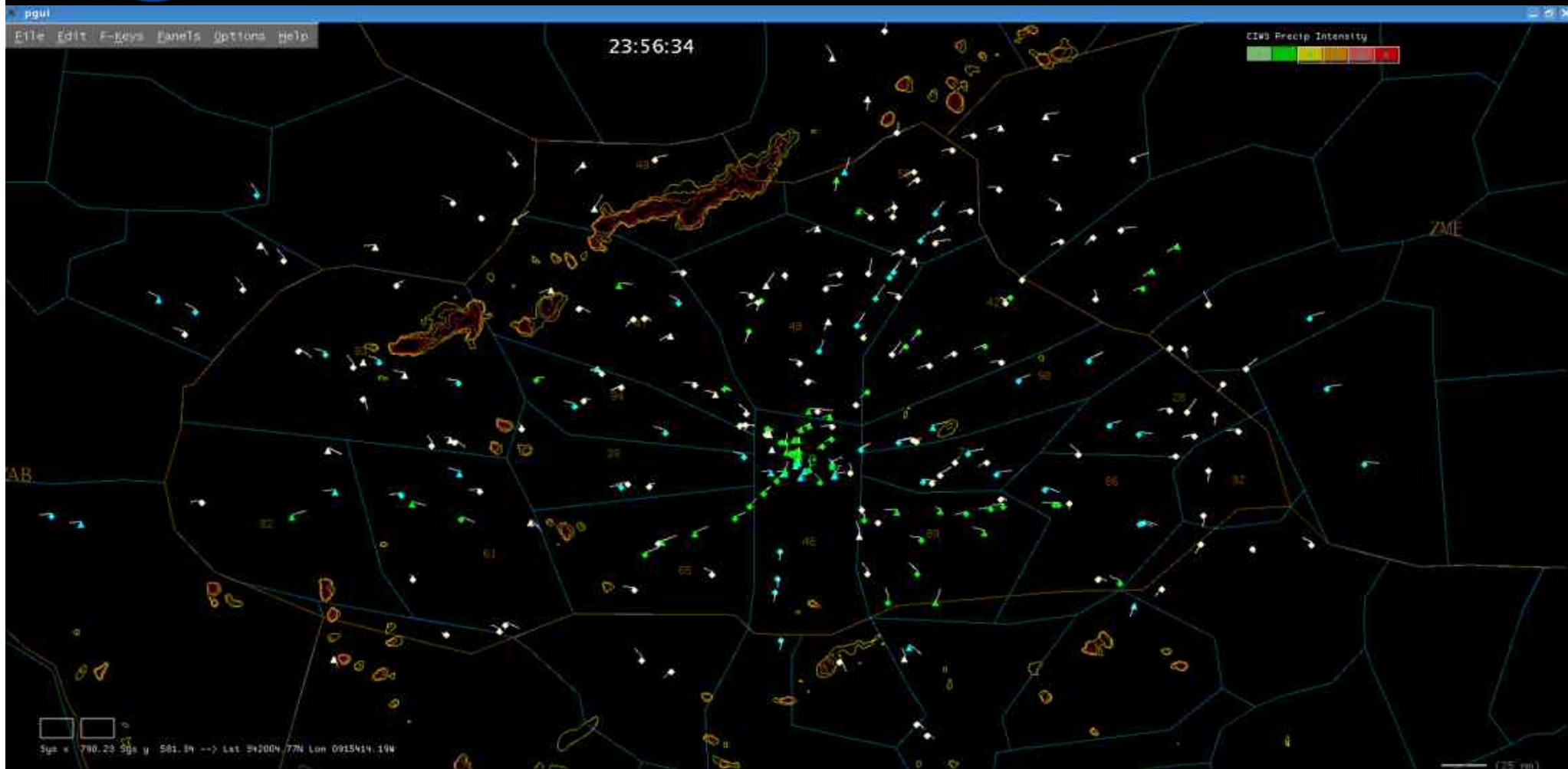


# Resolve Traffic Conflicts





# Setup for Example Cases





# UAL975 IAD/SFO





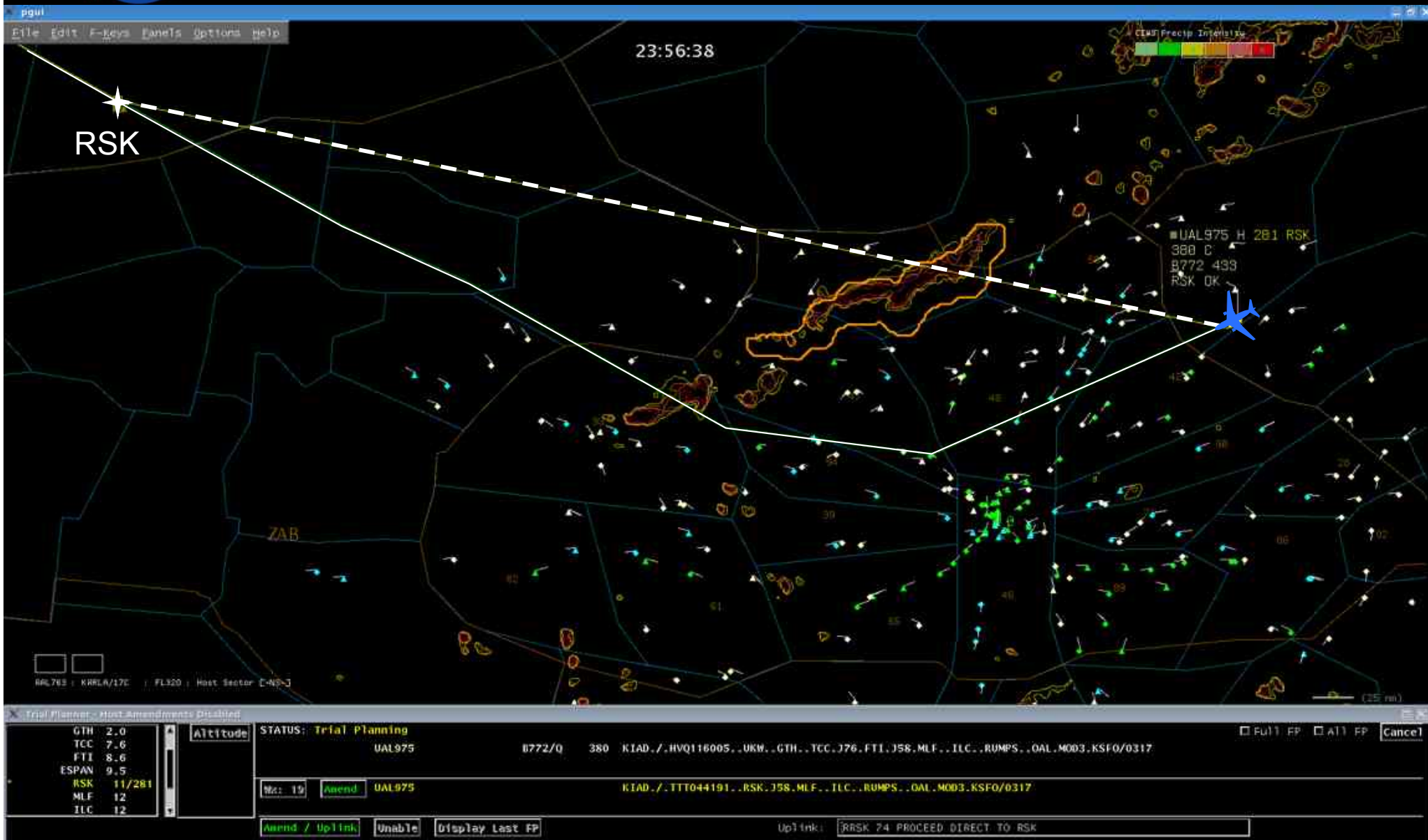
# Flight Plan Route







# Direct-To Route





# Best Aux Waypoint Route





# Snap to Fix Route







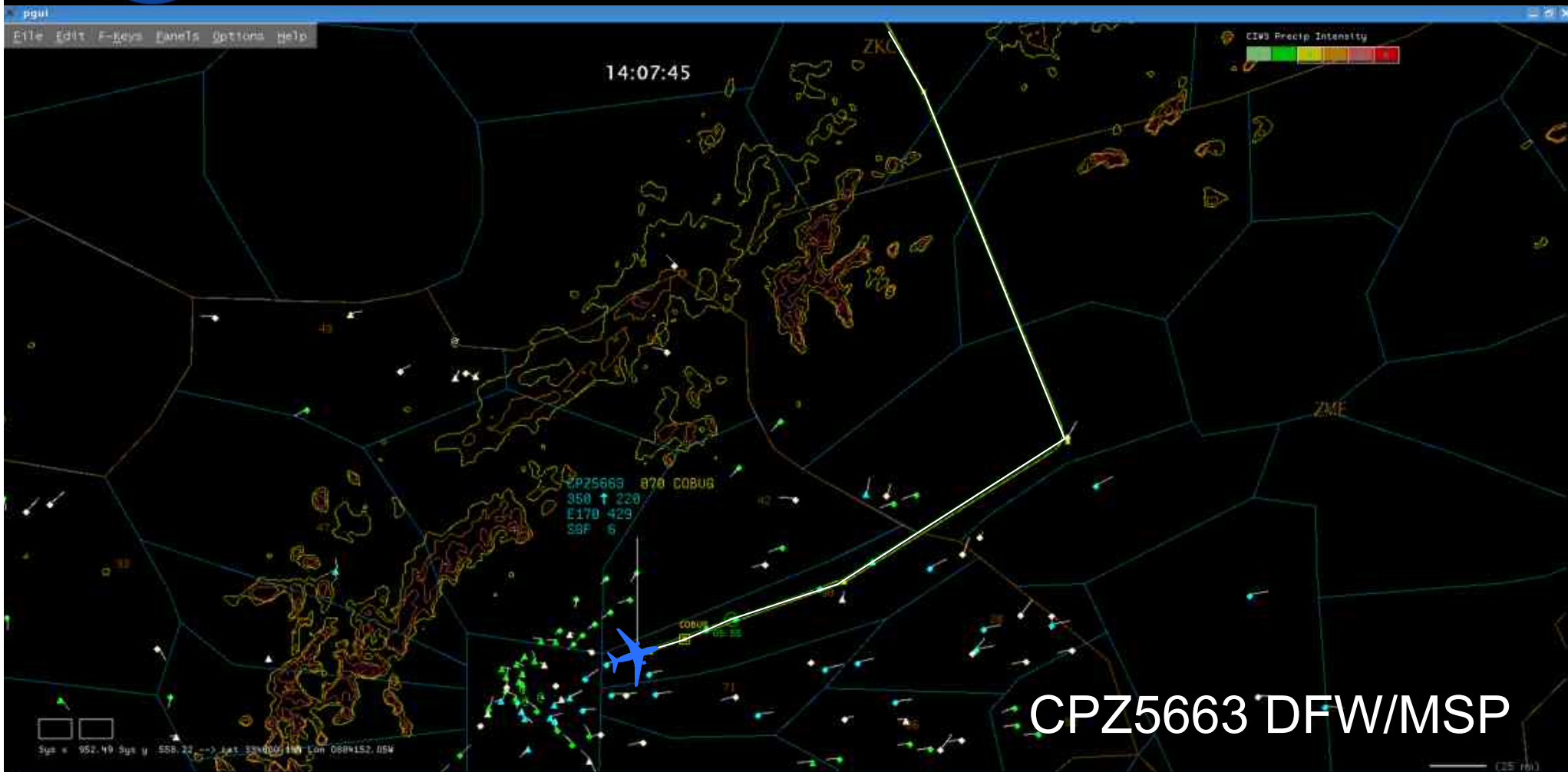
# Actual Track





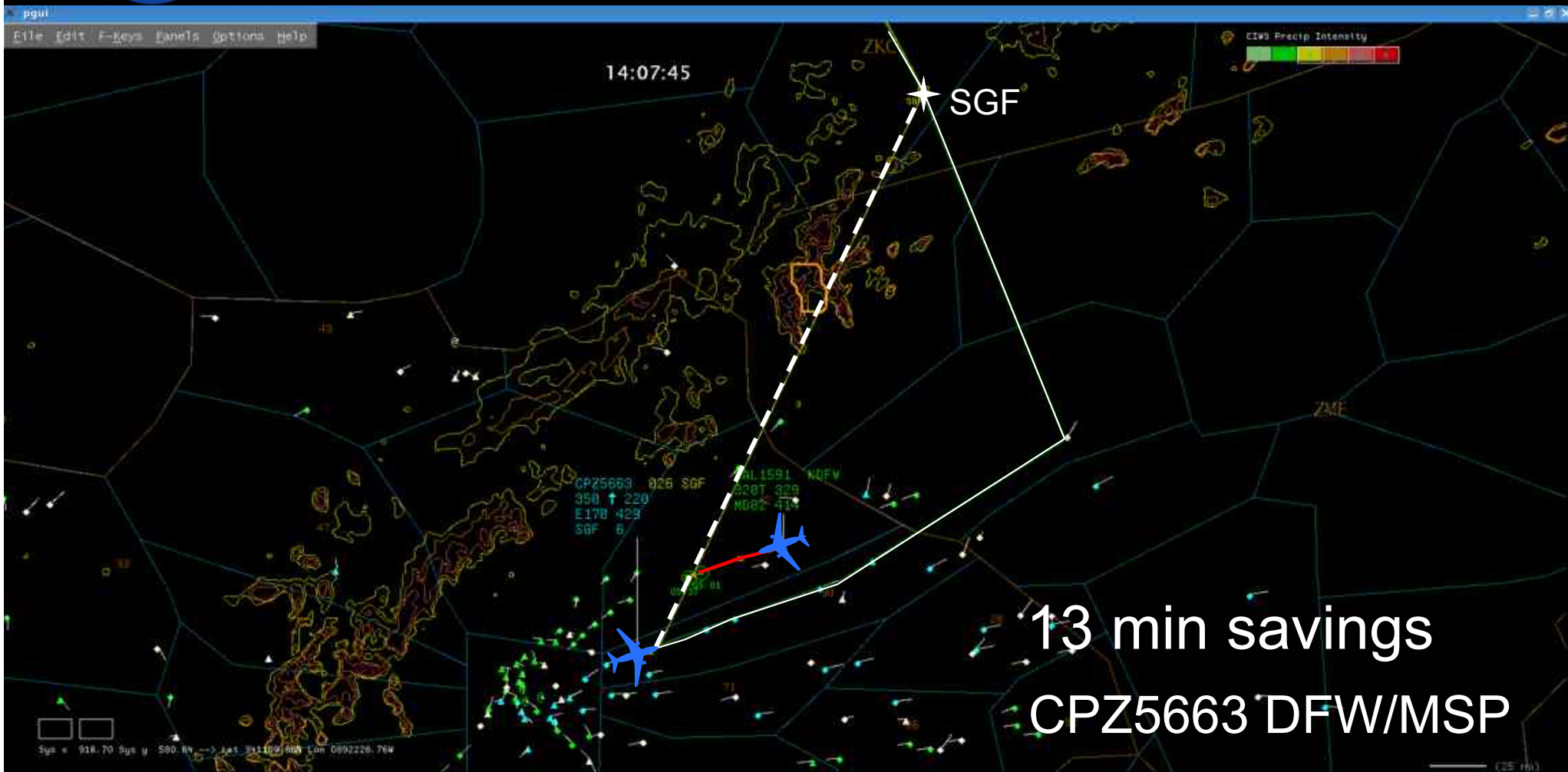


# Flight Plan Route



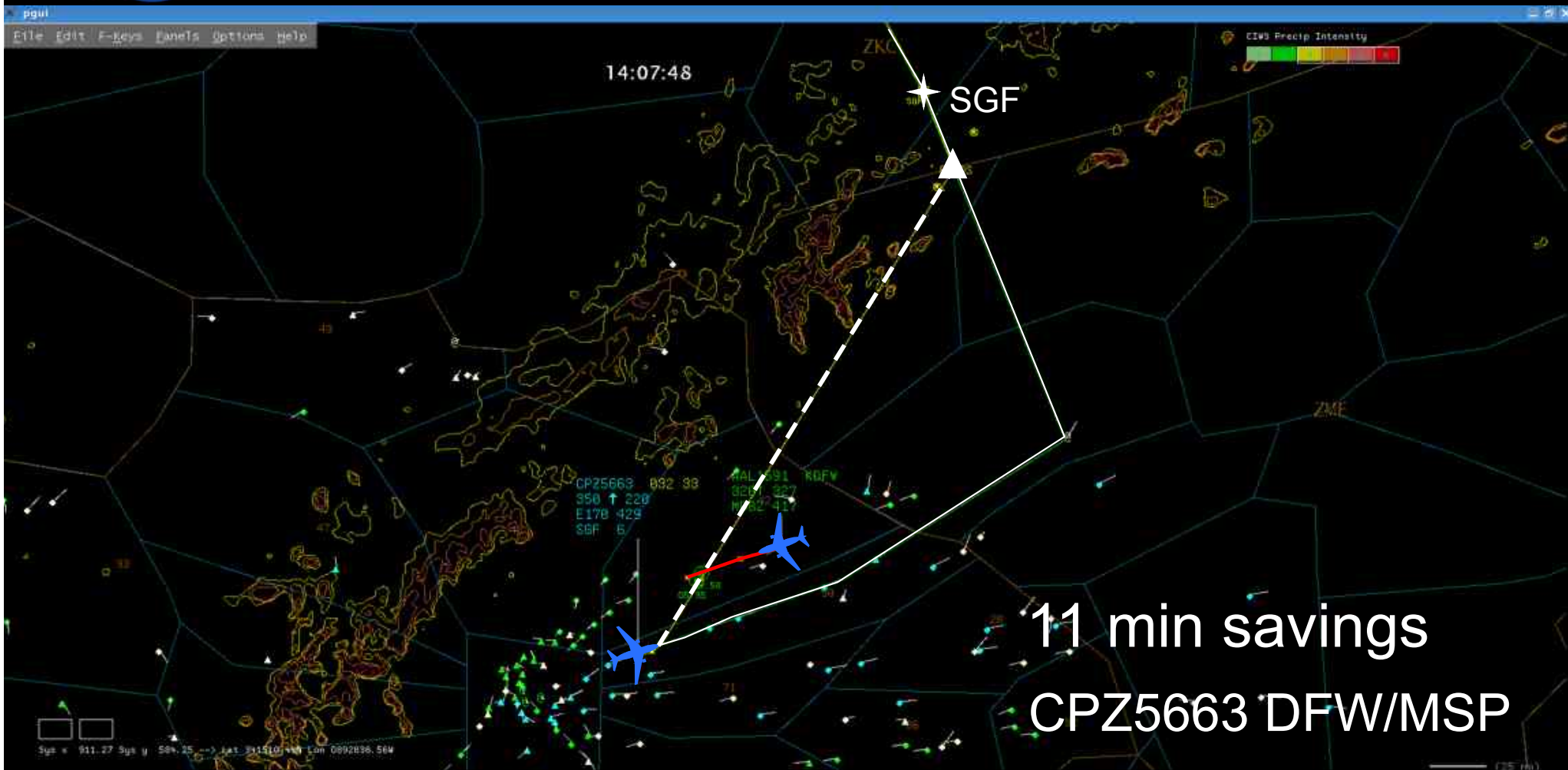


# Direct-To Route





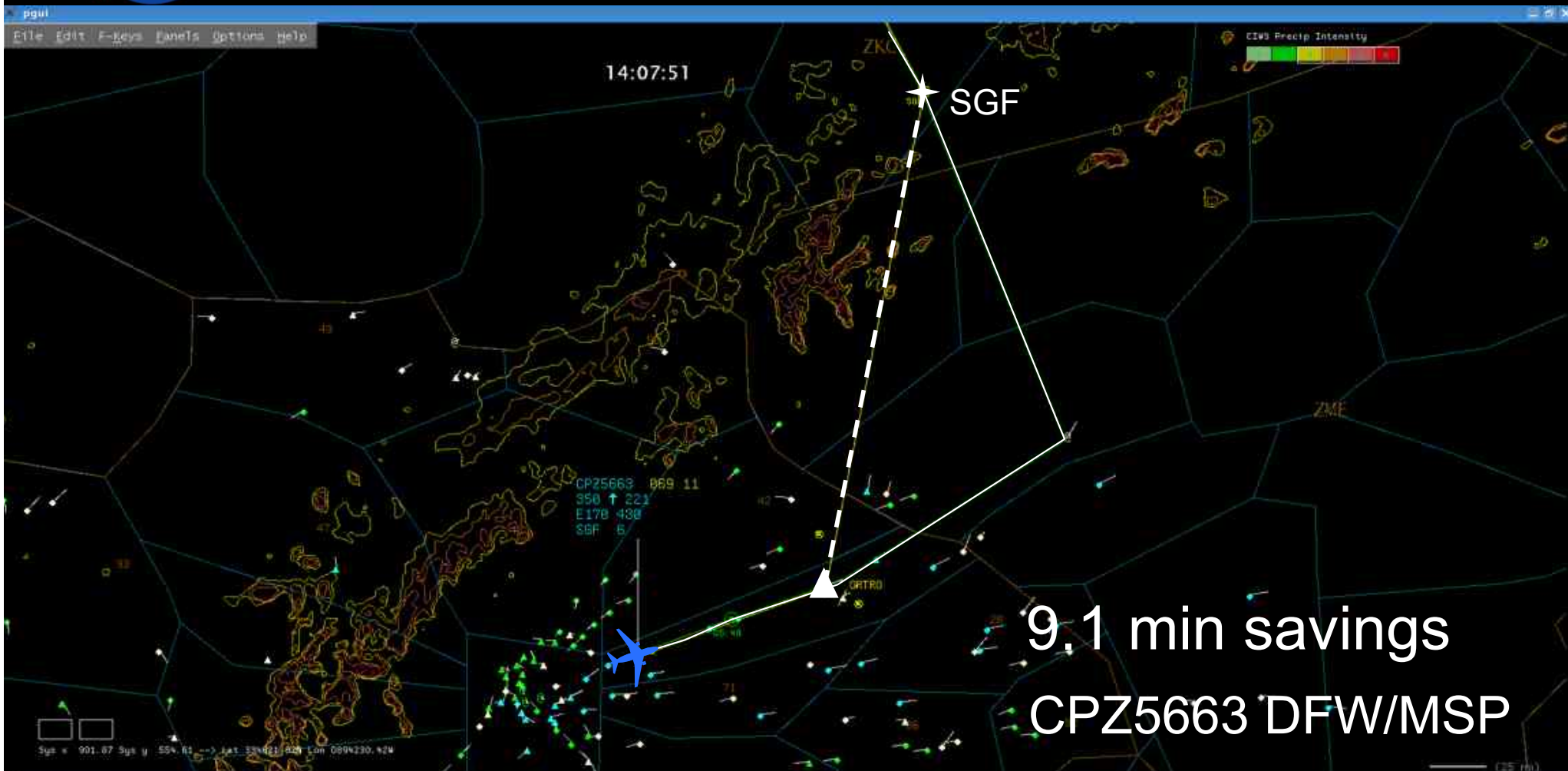
# Weather Resolved Route





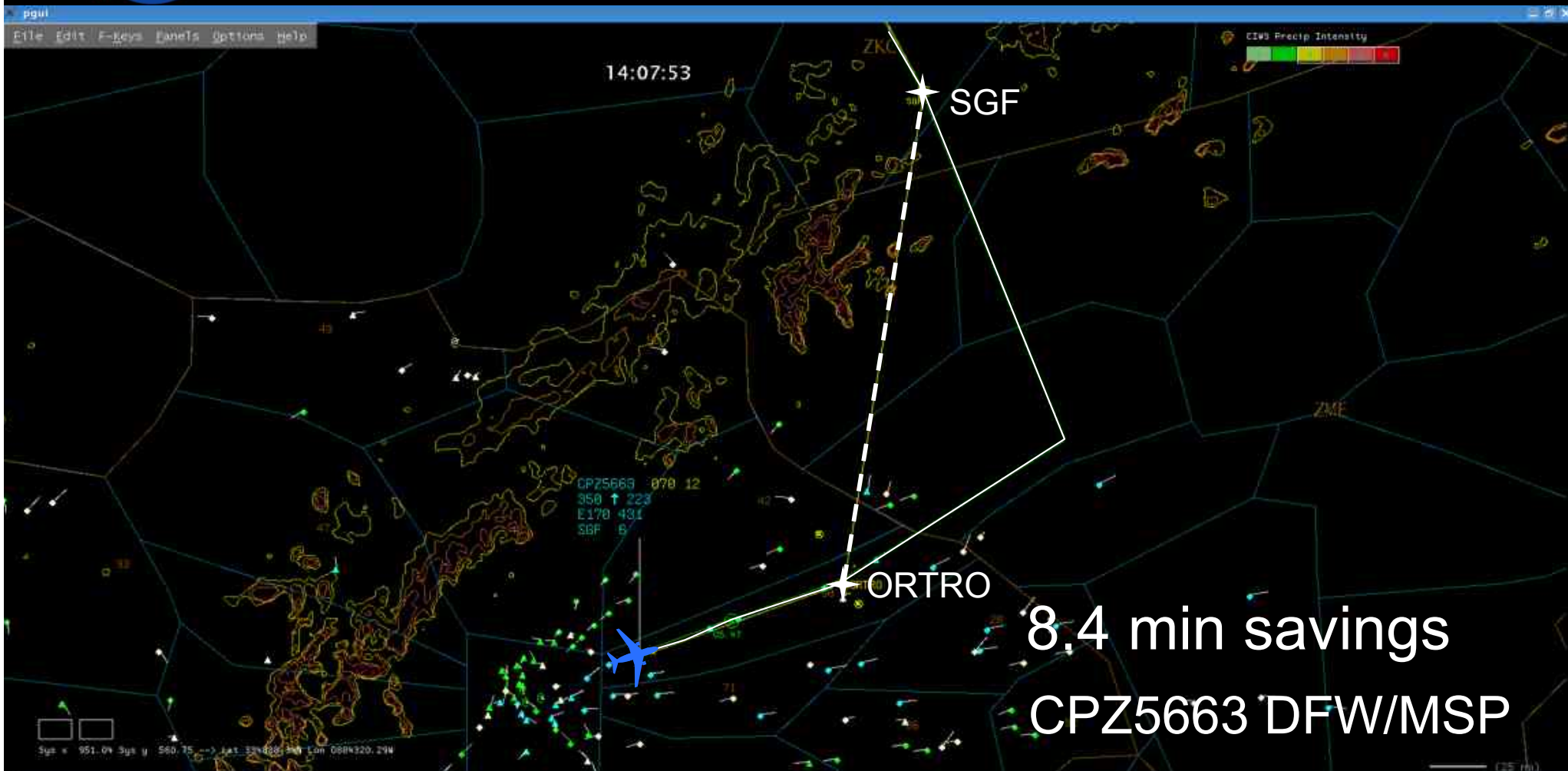


# Weather & Traffic Resolved Route



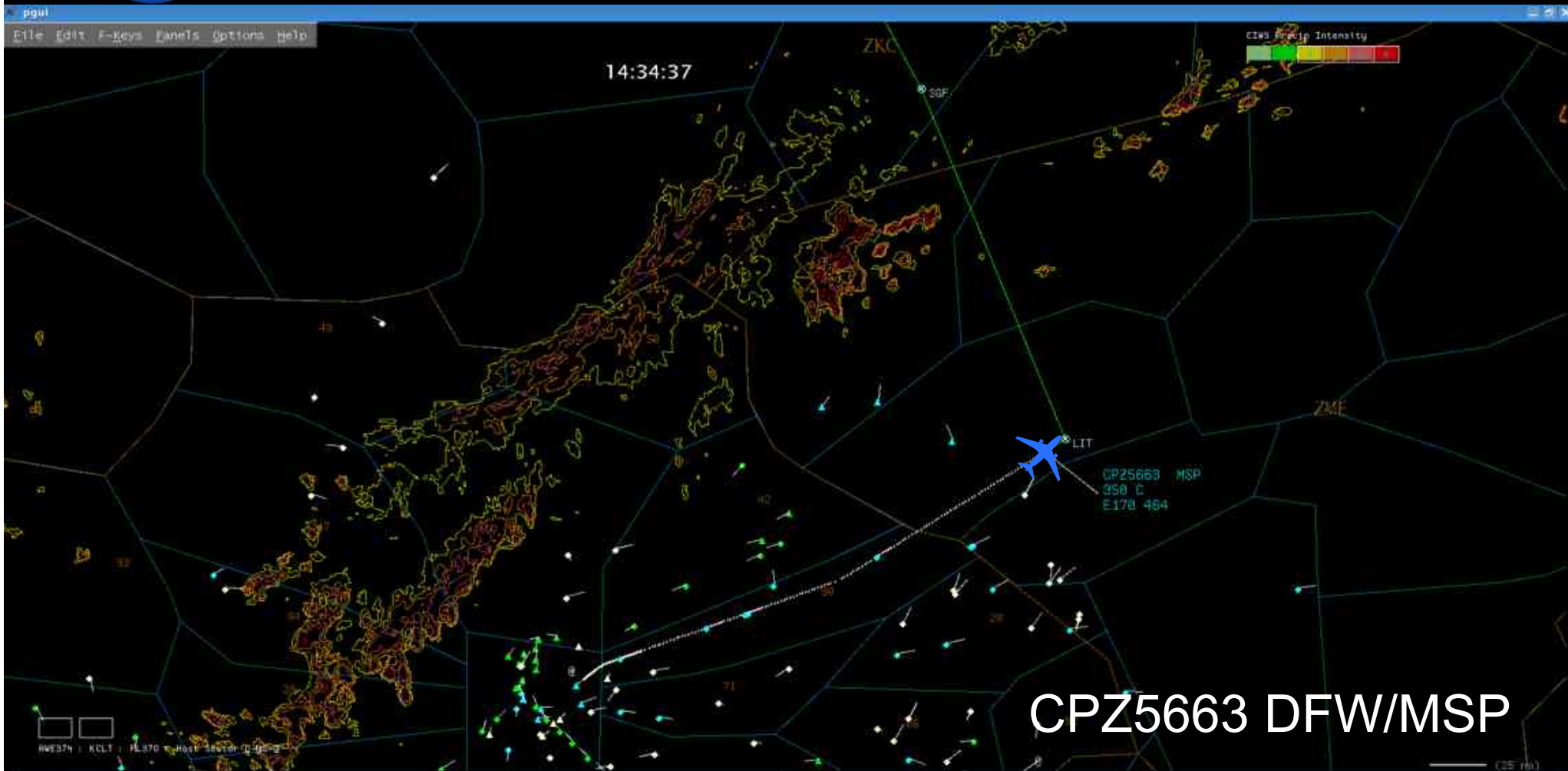


# Snap to Fix Route





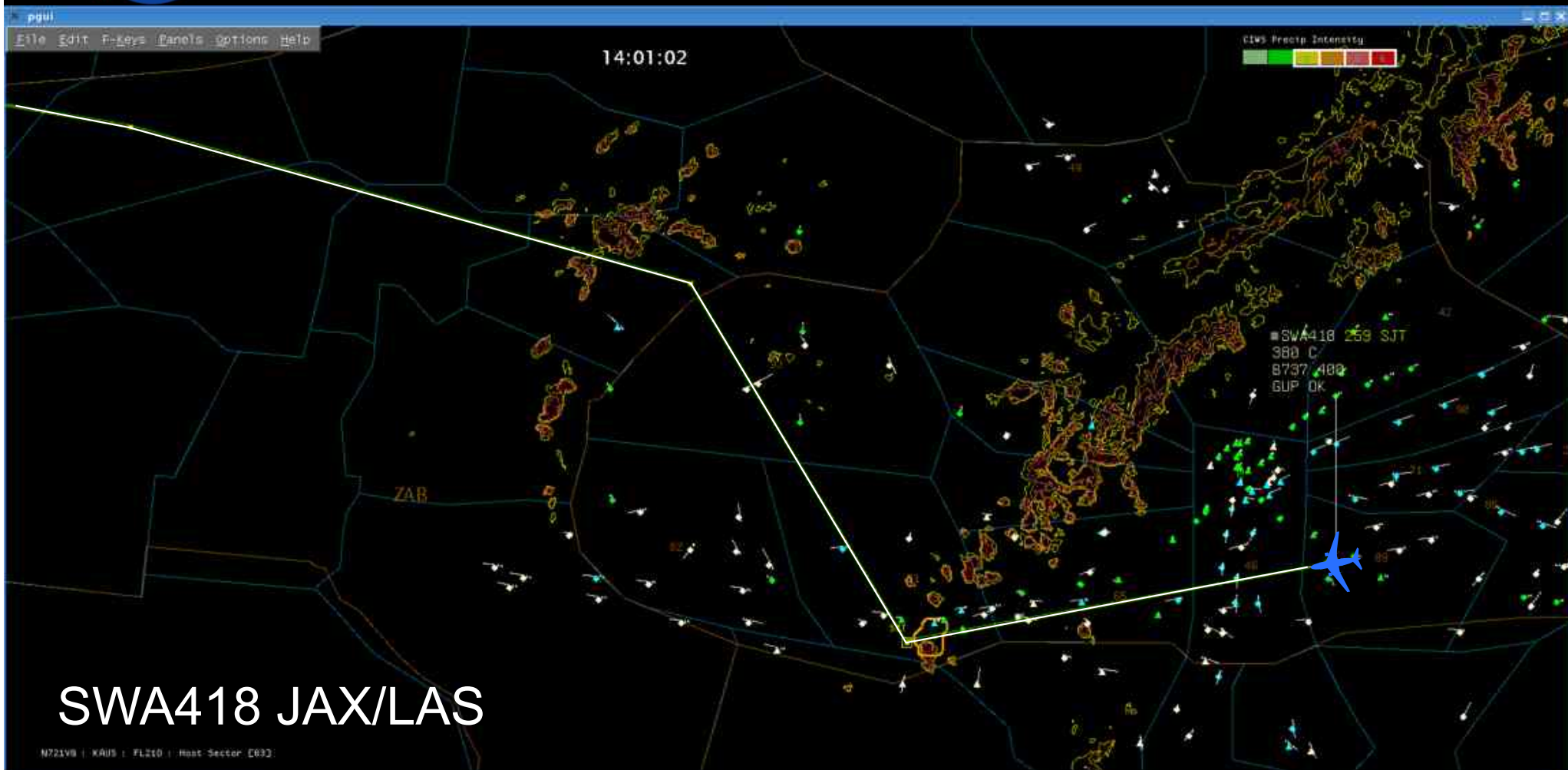
# Actual Track





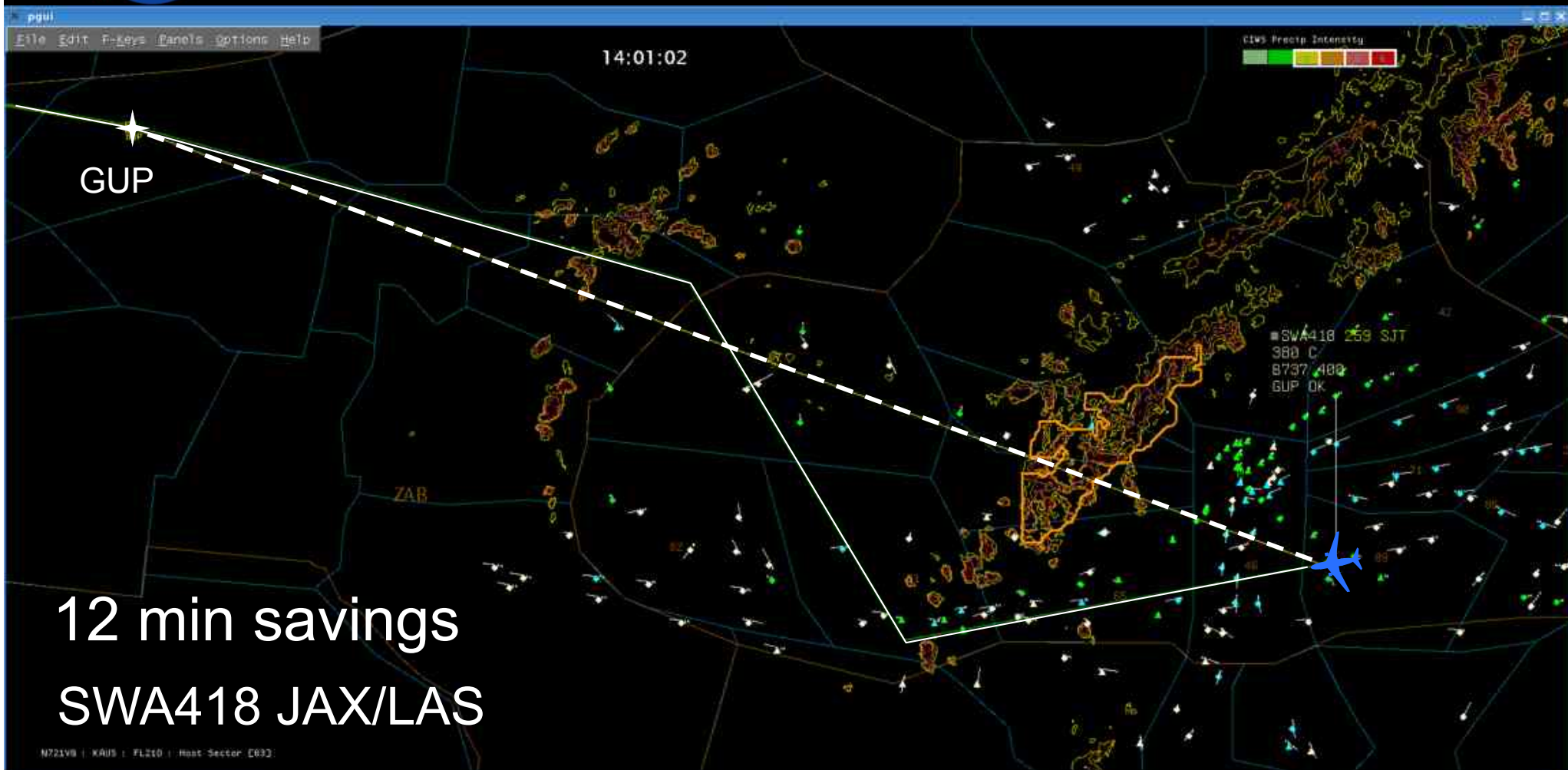


# Flight Plan Route





# Direct-To Route





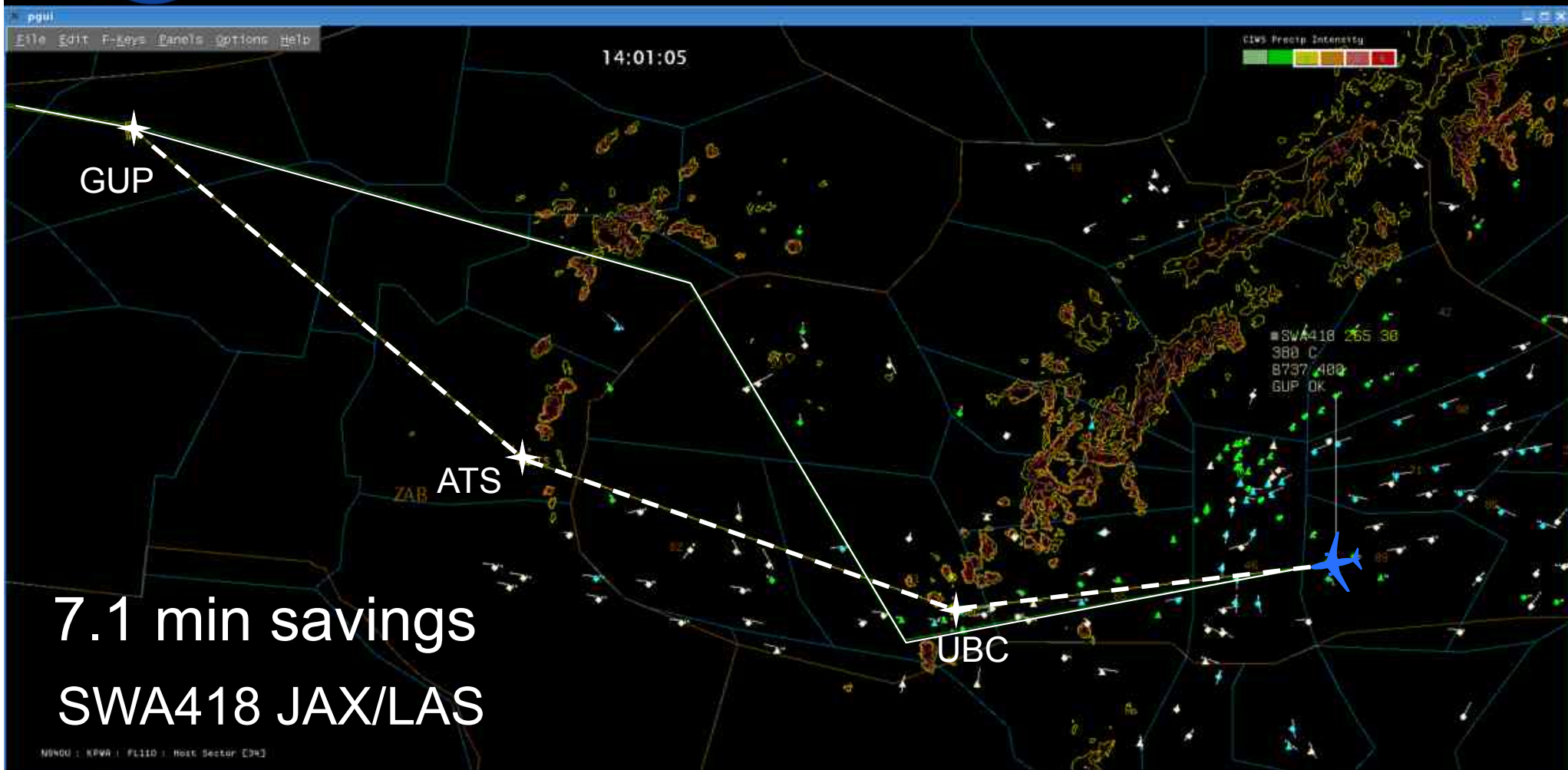


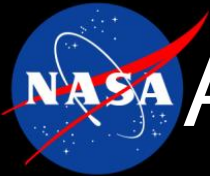
# Best Aux Waypoint Route



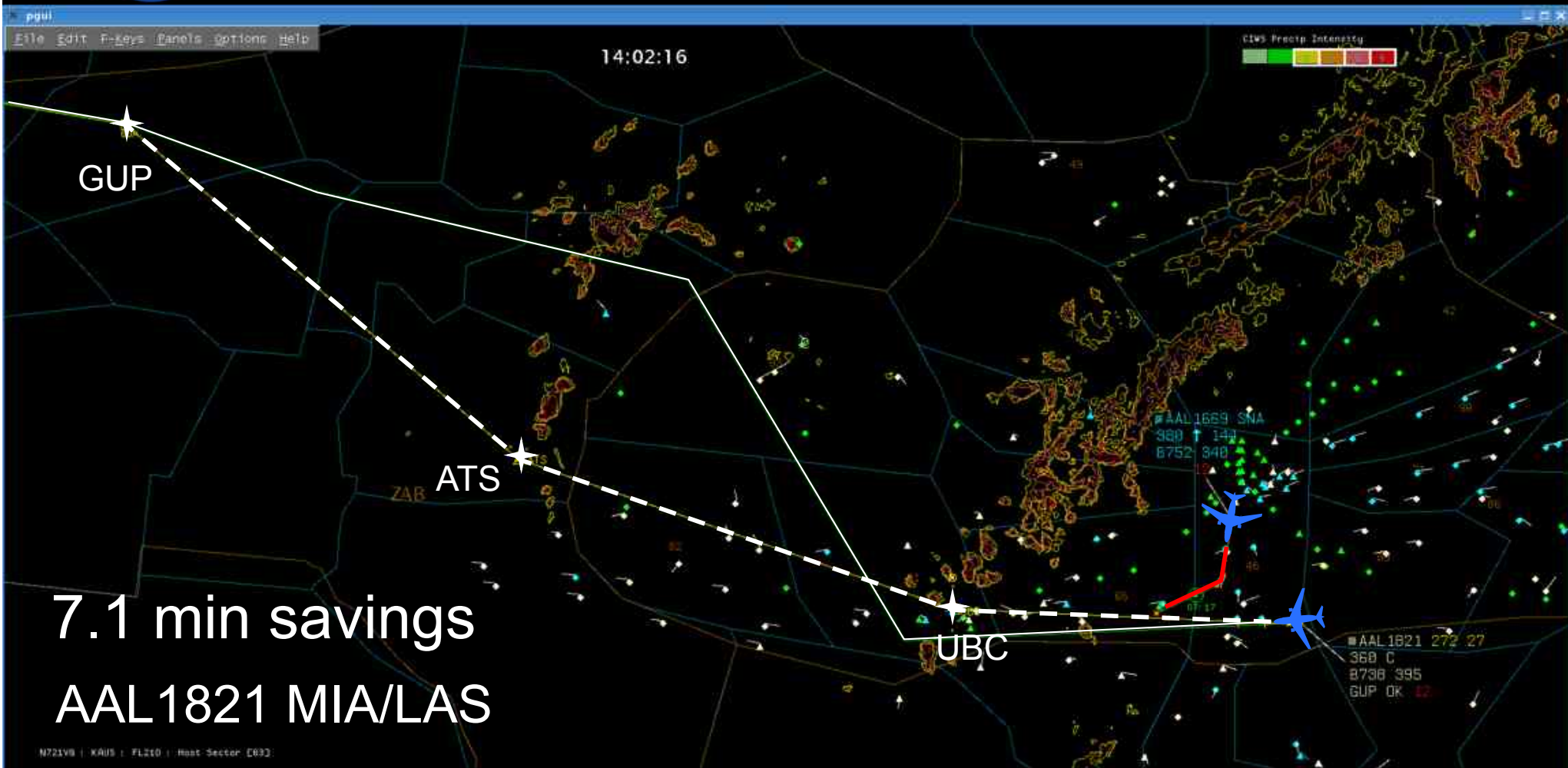


# Snap to Fix Route





# Another LAS Flight, Same Route







# Actual Tracks, 4 LAS Arrivals





# Metrics

SWA418 JAX/LAS	Weather Conflicts (min to LOS)	Traffic Conflicts (min to LOS)	Number aux way- points	Time savings (min)
Flight plan route				
Direct-To route				
Best aux waypoint route				
Snap to fix route				
Best aux waypoint route, traffic conflict-free				



# Metrics

SWA418 JAX/LAS	Weather Conflicts (min to LOS)	Traffic Conflicts (min to LOS)	Number aux way- points	Time savings (min)
Flight plan route	24	0	---	---
Direct-To route				
Best aux waypoint route				
Snap to fix route				
Best aux waypoint route, traffic conflict-free				



# Metrics

SWA418 JAX/LAS	Weather Conflicts (min to LOS)	Traffic Conflicts (min to LOS)	Number aux way- points	Time savings (min)
Flight plan route	24	0	---	---
Direct-To route	14	0	0	10
Best aux waypoint route				
Snap to fix route				
Best aux waypoint route, traffic conflict-free				



# Metrics

SWA418 JAX/LAS	Weather Conflicts (min to LOS)	Traffic Conflicts (min to LOS)	Number aux way- points	Time savings (min)
Flight plan route	24	0	---	---
Direct-To route	14	0	0	10
Best aux waypoint route	0	0	2	7.0
Snap to fix route				
Best aux waypoint route, traffic conflict-free				





# Metrics

SWA418 JAX/LAS	Weather Conflicts (min to LOS)	Traffic Conflicts (min to LOS)	Number aux way- points	Time savings (min)
Flight plan route	24	0	---	---
Direct-To route	14	0	0	10
Best aux waypoint route	0	0	2	7.0
Snap to fix route	0	0	2 (UBC, ATS)	6.7
Best aux waypoint route, traffic conflict-free				



# Metrics

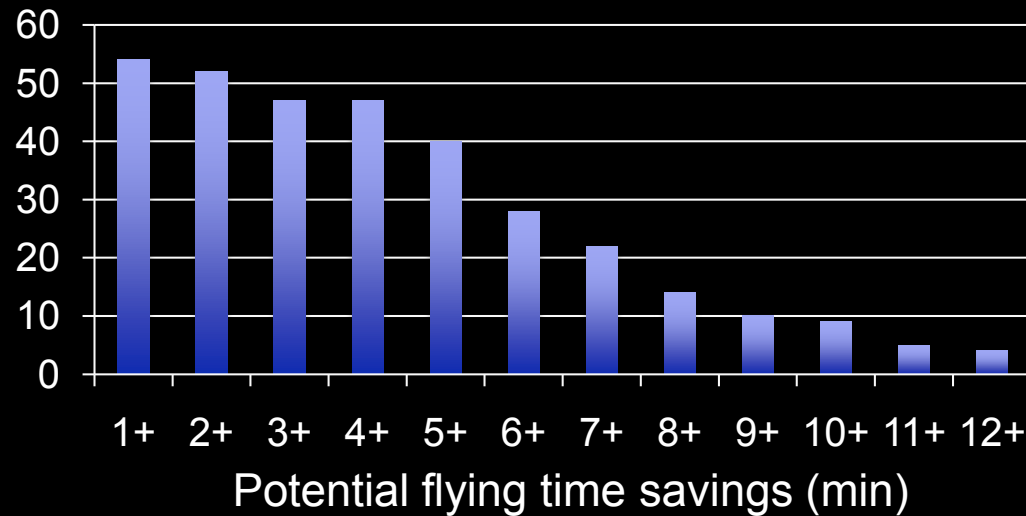
SWA418 JAX/LAS	Weather Conflicts (min to LOS)	Traffic Conflicts (min to LOS)	Number aux way- points	Time savings (min)
Flight plan route	24	0	---	---
Direct-To route	14	0	0	10
Best aux waypoint route	0	0	2	7.0
Snap to fix route	0	0	2 (UBC, ATS)	6.7
Best aux waypoint route, traffic conflict-free	N/A	---	---	---



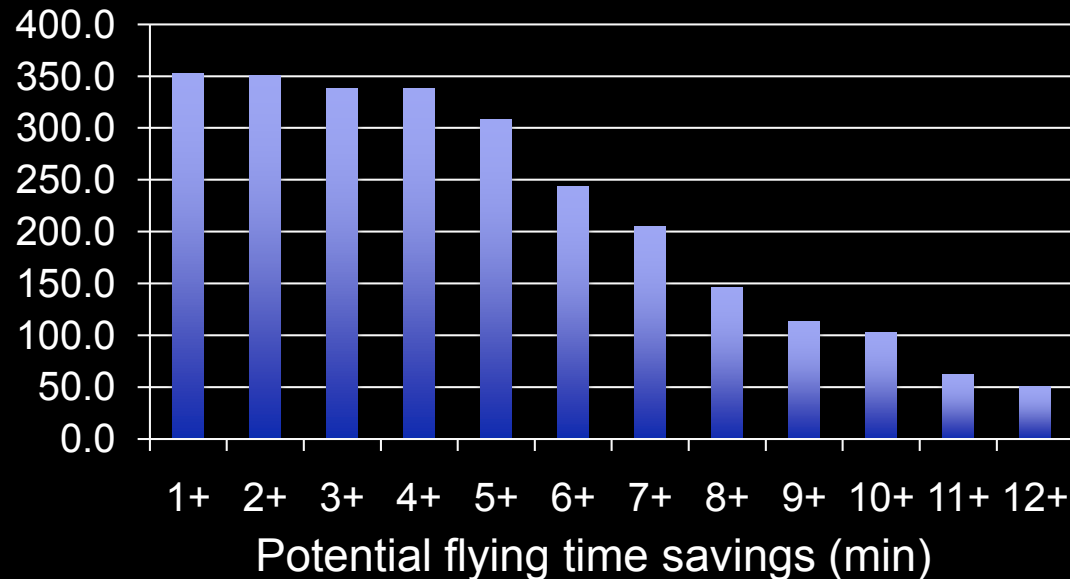
# Potential Flying Time Savings

*5 hours Fort Worth Center traffic over 2 weather days*

Number  
of flights



Total  
potential  
savings  
(min)





# Challenges

- Objective criteria for consideration
- Common stakeholder (FAA, airspace users) understanding of
  - Controller workload, Playbook non-conformance (cost)
  - Airspace user savings (benefit)
- Who initiates? AOC requests when potential savings greater than parameter (8 min?)
- Operational trials to validate concept



# Concluding Remarks

- Large potential for time and fuel savings
- Simple route changes enabled by trajectory automation, weather modeling, and air/ground data comm - no new aircraft equipage
- Common objective stakeholder consideration criteria a key requirement
- Next Steps:
  - Expand benefits analysis using more actual traffic samples
  - Collaborate with FAA and airspace users on operating concept
  - Simulations, field trials

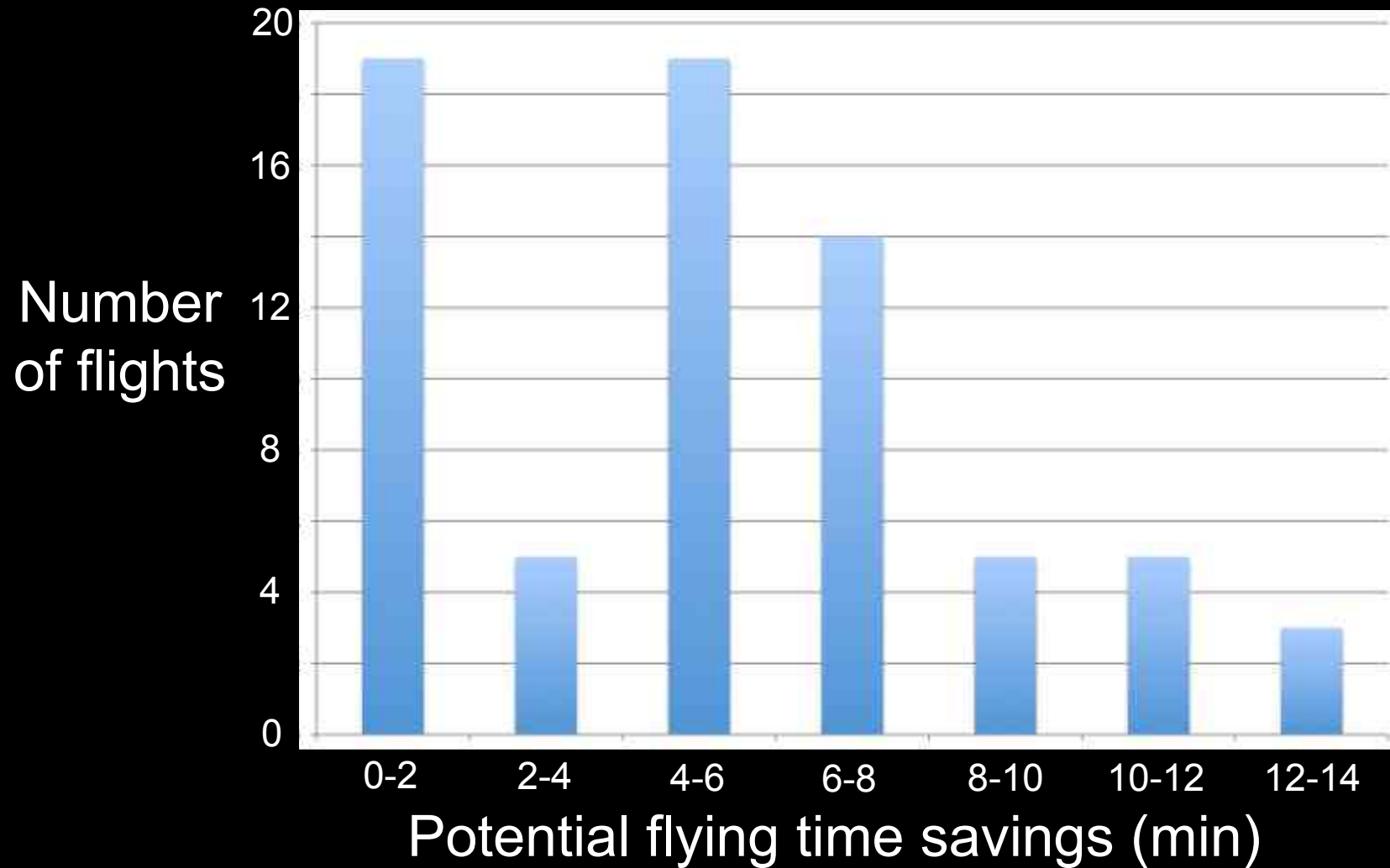


# Extra Slides



# Potential Flying Time Savings

*5 hours Fort Worth Center traffic over 2 weather days*





# Concluding Remarks

- Large potential benefits: 354 min flying time savings in 5 hours of weather-impacted ZFW traffic
- Enabled by integrated trajectory automation: wind-favorable routes, weather modeling, rapid feedback trial planning, autoresolver for weather and traffic
- Concept integrates cleanly with today's air/ground data comm (FANS-1/A) -- no new aircraft equipage
- Next Steps
  - Automate real-time weather reroutes (AAC autoresolver)
  - Expand lab analysis of benefit potential
  - Study operating concept options (who initiates, TFM metrics)
  - Stakeholder feedback





# Potential Flying Time Savings

*5 hours Fort Worth Center traffic over 2 weather days*

